DOCUMENT RESUME

ED 309 927 SE 050 755

AUTHOR Ware, Mark E.; Chastain, Jeffrey D.
TITLE Person Variables Contributing to Success in Introductory Statistics.
PUB DATE Apr 89
NOTE 17p.; Paper presented at the Annual Meeting of the Southwestern Psychological Association (35th, Houston, TX, April 13-15, 1989).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Attitude Measures; *College Mathematics; *Competence; Computer Literacy; Grade Point Average; Higher Education; *Mathematics Achievement; *Predictor Variables; *Sex Differences; *Statistics

ABSTRACT

The purpose of this paper was to identify the role of several person variables (gender, mathematics competency, attitudes toward statistics, computer competency, and grade point average) contributing to success in introductory statistics. The performance of 103 students on four examinations during a semester constituted the dependent variable. A two-by-two factorial design with two groups for gender and two groups for each of the four self-report variables was used. The results of analysis of variance failed to reveal a difference between men and women and between high and low groups on mathematics competency, computer competency, and attitudes toward statistics. A significant difference was found in test performance between high and low grade point average groups and a significant interaction was found between gender and mathematics competency. The interaction showed that women had lower scores than men when both reported having less mathematics competency. Findings suggest that the role of person variables depends, in part, on the operational definition that investigators use. (Author/YP)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED309927

Person Variables Contributing to Success in Introductory Statistics

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

This document has been reproduced as received from the person or organization originating it.

Minor changes have been made to improve reproduction quality.

Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

Mark E. Ware

Jeffrey D. Chastain

Creighton University

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Mark Ware

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Paper presented at the Annual Meeting of the Southwestern Psychological Association (35th, Houston, TX, April 13-15, 1989).

SE 050 755

BEST COPY AVAILABLE

Abstract

We sought to identify the role of several person variables (gender, math competency, attitudes toward statistics, computer competency, and GPA) contributing to success in introductory statistics. The performance of 103 students on 4 examinations constituted the dependent variable. We used a 2 x 2 factorial design with two groups for gender and two groups for each of the self-report variables. The results of analysis of variance failed to reveal a difference between men and women and between high and low groups on math competency, computer competency, and attitudes toward statistics. We did find a significant difference in exam performance between high and low GPA groups and a significant interaction between gender and math competency. Findings suggest that the role of person variables depends, in part, on the operational definition that investigators use.

Person Variables Contributing to Success in Introductory Statistics

Bartz's finding (1981) that 72% of four-year colleges and universities offering a psychology major required at least one course in statistics illustrates the prevalence of statistics as a requirement in the psychology curriculum. One would think that the widespread requirement of statistics means that educators have given it its share of attention in the scholarly literature. Indeed, the literature on teaching statistics is sparse; Ware and Brewer (1988) reported only 31 articles published in Teaching of Psychology since 1974.

The research on gender differences in statistics has been equivocal Some evidence indicates that there are gender differences among undergraduate (Brooks, 1987) and graduate students (Woehlke & Leitner, 1980). However, other results indicate no differences among undergraduates (Buck, 1985, 1987) and graduate students (Elmore & Vasu, 1980).

Whereas Giambra (1970; 1976) did not find that students' math background predicted success in statistics. Woehlke & Leitner (1980) found performance on a math skill pretest did predict performance in a graduate level statistics course. Similarly, Kirk, Gerbing, Foster & Buchanan (1987) found that scores on a test of math skills predicted success in introductory statistics. These findings suggest that the accurate prediction of success in statistics appears to depend on the measure of math competency.

Elmore and Vasu (1980) also investigated the role of attitudes toward math in predicting success in statistics. They used the nine scales of the Fennema-Sherman Mathematics Attitudes Scales. The finding were that

confidence in learning mathematics had the highest correlation with total points in a statistics course. We suspected that other attitudinal measure, such as attitudes toward statistics might be related to statistical performance.

Increasing numbers of teachers are using micro and mainframe computers in teaching statistics (Castellan, 1982; Couch & Stoloff, 1986; Stoloff and Couch, 1987). Because of the perceived relationship between math and computer competency, there is a need to examine the role of computer competency in predicting success in statistics even when the grade in the course does not require computer competency.

Several investigators have tried to determine which students are likely to have difficulty in introductory statistic. Breland (1981), Educational Testing Service (1948-1985) and Giambra (1976) found that students' cumulative grade point average (GPA) predicted performance in an introductory statistics class.

The purpose of the present study was to clarify the role of gender and math skill in predicting success in statistics, to expand knowledge about the role of attitudes toward statistics and computer competency, and to re-examine the role of GPA. In short, we sought to understand the influence of several person variables contributing to success in an introductory statistics course.

Method

Subjects

Subjects were 103 undergraduates who volunteered to participate in the study. The students were enrolled in four sections of an introductory statistics course from fall 1986 through spring 1988. Overall, women constituted 57% and men 43% of the sample. Freshmen, sophomores, juniors, seniors, and special students constituted 3%, 28%, 47%, 17%, and 5% of the sample respectively.

Materials

The first author developed an inventory that asked students to report their gender. Students rated their math competency using a 9-point scale ranging from very low (0) to moderate (4 or 5) to very high (9).

The first author selected 4 bipolar items that loaded .82 or higher on the Semantic Differential's evaluative factor (Osgood, Suci, & Tannenbaum, 1957), including good-bad, cruel-kind, clean-dirty, and beautiful-ugly. We added each student's ratings on the 4 items to obtain a total score for attitudes toward statistics. A higher score meant a more favorable attitude toward the concept. Students rated their computer competency using the same 9-point scale as for rating their math competency.

The inventory also asked students to report their overall GPA. Students selected one of nine categories that contained their overall GPA. The lowest category was less than 2.35, and the highest category

was greater than 3.74. The other categories consisted of intervals of .20, for example 2.95-3.14.

Procedure

The topics in the introductory statistics course included measures of central tendency and variability, correlations and regressions, z-test, t-test, analysis of variance, and nonparametric statistics. Students completed the inventory during the first week of the semester. A total of 103 students completed the inventory, and 100 students completed the course. Thus attrition was 3%.

The dependent variable was the total number of points students obtained on the four examinations during the semester. We converted the total number of points for students in each section to T-scores with a mean of 70 and a standard deviation of 10.

Analysis and Design

The design of this study was a 2 x 2 factorial design using two groups for gender (men and women) and two groups for each of the self report variables of math competency, attitudes toward statistics, computer competency, and GPA. In all cases except gender, we formed groups by dividing the students' responses into low and high using the median as the fulcrum value. We included the gender variable in each analysis in an effort to clarify conditions under which gender predicts or fails to predict success in statistics in combination with other person variables, that is to discover variables that interact with gender.

Results

The results of the analysis of variance failed to find significant differences in total number of points on examinations for the variables of gender, math competency, attitudes toward statistics, and computer competency. However, there was a significant difference in test performance for the GPA variable. Students classified as having higher GPA had higher examination performance than those classified as having lower GPA's, $F(1, 74) = 5.83$, $p \leq .05$. Table 1 contains the means, standard deviations, and sample sizes for all groups.

Insert Table 1 about here

There was also a significant interaction between gender and math competency, $F(1, 98)=5.28$, $p<0.05$. Women had higher test scores than men when both reported that they were more math competent (M=71.9 vs. 69.6), however, the difference was not significant, $t(43)=.09$, $p=0.39$. Women had lower scores than men when both reported having less math competency (M=65.9 vs. 72.6), and the difference was significant, $t(46)=-2.50$, $p=.02$.

Discussion

The failure to find significant differences in performance in statistics classes for men and women is similar to some findings (Buck, 1985, 1987; Elmore & Vasu, 1980) but not with others (Brooks, 1987; Woehlke & Leitner, 1980). We cannot be sure whether the inconsistencies in findings reflect an unstable phenomenon, differences in sampling, the nature of the dependent

variable, or other factors. Woehlke & Leitner (1980) used a statistics inventory that was independent of students' grade in the course to determine performance in statistics. By contrast, the dependent variable in the present and other studies (Buck, 1985, 1985) constituted a major component in determining the students' grade in the course. Thus, the gender difference that Woehlcke & Leitner (1980) reported might reflect women's greater skill or motivation to achieve on that measure. However, Brooks' findings (1987) of gender differences using course performance as the dependent variable is not consistent with the explanation we propose. Additional research is needed to clarify inconsistencies in results involving gender differences in statistics performance with particular attention given to the operational definition of the dependent variable.

Our failure to find differences in statistics performance by those reporting high and low math competency is consistent with Giambra's (1970, 1976) failure to find differences among those having greater or lesser amounts of background in math (i.e., number of math courses) The finding of the present study is inconsistent with two studies (Kirk et al., 1987; Woehlke & Leitner, 1980) that found differences in statistics performance as a function of performance on math skills tests. Our failure to find differences between high and low math competency groups may reflect individuals' inaccurate assessment of their math competency rather than the lack of an effect of math competency. Many of our undergraduates pursue post graduate study in the health professions, and many take rigorous courses in math. Students in introductory statistics are almost exclusively psychology

majors and consist of a very heterogeneous group with regard to post graduate plans. The math background of these students varies widely. They may not have a realistic assessment of their math competency in the context of the many highly math competent students.

The failure to find significant differences in statistics performance between high and low attitudes toward statistics groups is not consistent with Elmore & Vasu findings (1980) of a high relationship between confidence in learning math and total points in a statistics course. Our measure of attitudes toward statistics and their measure of confidence in learning math may constitute a pool of attitudinal measures predicting success in statistics. A need exists to discover what if any role attitudinal measures contribute to success in statistics.

The failure to find differences in statistics performance between those in the high and low computer competency groups was not a complete surprise. On the one hand, we discovered a small but significant correlation between math and computer competency $r(102)=.26$, $p=.004$. As mentioned above, we found no differences in statistics performance between the math competency groups. On the other hand, the lack of difference in performance between the computer competency groups might also reflect the course's structure and contents, which did not require previous knowledge of computers to understand the statistical concepts.

The higher statistics performance for those with higher GPAs is consistent with the results of several studies (Breland, 1981; Educational Testing Service, 1948-1985; Giambra, 1976). Collectively, those findings

suggest that general academic ability is the single best predictor of success in statistics. The variety of skills, attitudes, and motivational forces contributing to overall success in college may also contribute to a high level of performance in an introductory statistics class. Preliminary findings (Ware & Chastain, 1988) indicate that an instructional strategy of emphasizing selection skills in statistics can increase students' selection skills for students in high and low GPA groups. However, within the group having a high emphasis on selection skills, students with higher GPAs had higher scores on the selection measure than students with lower GPA's. Although instructional strategies may increase the skill level for students with lower GPA, students with lower GPAs are not likely to match or outperform those with higher GPAs.

An explanation for the results of the interaction between gender and math competency was not immediately apparent. Why should men who rated themselves low in math competency outperform women who rated themselves low in math competency. We asked and answered two other questions. Did the men and women in the low math competency group have different GPAs? Results of Mann Whitney U analysis failed to find differences in GPAs between men and women, $z=0.08$, $p=0.94$. Did the men and women in the low math competency group have equal ratings of math competency? Results of t-tests revealed a significant difference, $t(46)=-3.04$, $p=0.004$. Men gave a higher rating of math competency ($M=4.00$ $SD=1.45$) than women ($M=2.58$ $SD=1.75$).

As mentioned above, many of our undergraduates take rigorous math courses as part of their preparation for pursuing health careers. Most of

those students are men, despite the fact that women constitute slightly more than 50% of the undergraduate population. One reason the men outperformed the women in the low math competency group is because of their relative math superiority. Additional research could confirm our findings by obtaining conventional measures as well as self-ratings of math competency, comparing the two, and determining whether an interaction exists between gender and math competency when math competency is defined in terms of external versus internal criteria.

The results of the present study suggest that the role of personal variables contributing to success in statistics depends in part on the operational definition of those person variables. Closer attention to operational definitions and systematic efforts to compare results with studies having multiple operational definitions may help to explain the inconsistencies in the literature.

Additional research is needed to investigate the role of person variables and teaching strategies that optimize students' performance in introductory statistics. Ware and Chastain's (in press) research is one of the few contributions to that goal. They found that students taking an introductory statistics class with computer-assisted statistical analysis (CASA) had levels of statistical skills equivalent to those taught in the conventional way. However, the students in CASA had a significantly more favorable attitude toward statistics. The investigators also reported higher skill scores for men and for those with higher GPA's. We encourage other researchers to identify relevant person and instructional variables.

Overcoming students' frustrations and difficulties with statistics and promoting the development of a positive attitude toward statistics might be among the outcomes of such research.

References

Bartz, A. (1981). The statistics course as a departmental offering and major requirement. Teaching of Psychology, 8, 106.

Breland, H.M. (1981). Assessing student characteristics in admissions to higher education: A review of procedures (Research Monograph No.9). New York: College Entrance Examination Board.

Brooks, C.I. (1987). Superiority of women in statistics achievement. Teaching of Psychology, 12, 45.

Buck, J.L. (1985). A failure to find gender differences in statistics achievement. Teaching of Psychology, 12, 100.

Buck, J.L. (1987). More on superiority of women in statistics achievement: A reply to Brooks. Teaching of Psychology, 14, 45-46.

Castellan, N.J. (1982). Computers in psychology : A survey of instructional applications. Behavioral Research Methods, Instruments, & Computers, 14, 198-202.

Couch, J.V. & Stoloff, M.L. (1986, August). Computer use in psychology: A national Survey. Paper presented at the meeting of the American Psychological Association. Washington D.C.

Educational Testing Service. (1948-1985). Graduate record examinations. Princeton, NJ: Author.

Elmore, P.B., & Vasu, E.S. (1980). Relationships between selected variables and statistics achievement: Building a theoretical model. Journal of Educational Psychology, 72, 457-467.

Giambra, L.M. (1976). Mathematics background and grade-point average as

predictors of course grade in an undergraduate behavioral statistics course: A replication. Teaching of Psychology, 9, 221-222.

Giambra, L.M. (1970). Mathematics background and grade-point average as predictors of course grade in an undergraduate behavioral statistics course. American Psychologist, 25, 366-367.

Kirk, R.E., Gerbing, D., Foster, B., & Buchanan, R., (1987). Correlates of success in introductory statistics and measurement courses. Paper presented at the meeting of the Southwestern Psychological Association. New Orleans.

Osgood, C.E., Suci, G.J., & Tannenbaum, P.H. (1957). The measurement of meaning, Urbana, IL: University of Illinois Press.

Stoloff, M.L., & Couch, J.V. (1987). A survey of computer use by undergraduate psychology departments in Virginia. Teaching of Psychology, 14, 92-94.

Ware, M.E., & Brewer, C.L. (1988). Handbook for teaching statistics and research methods. Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Ware, M.E., & Chastain, J.D. (in press). Computer-assisted statistical analysis: A teaching innovation? Teaching of Psychology.

Ware, M.E., & Chastain, J.D. (1988). Developing selection skills in introductory statistics. Manuscript submitted for publication.

Woehlke, P.L., & Leitner, D.W. (1980). Gender differences in performance on variables related to achievement in graduate-level educational statistics. Psychological Reports, 47, 1119-1125.

Author Note

Preparation of this article was supported by a Creighton University Summer Faculty Research Fellowship.

Requests for reprints should be sent to Mark E. Ware, Department of Psychology, Creighton University, Omaha, NE 68178.

Table 1

Sample Sizes, Means and Standard Deviations for the Person Variables

Person Variables	N	M	SD
Gender			
Men	43	71.17	9.59
Women	56	69.09	10.11
Math Competency			
Low	48	68.97	9.86
High	51	70.95	9.92
Attitudes Toward Statistics			
Low	47	69.61	9.79
High	53	70.34	9.98
Computer Competency			
Low	54	71.35	9.50
High	46	68.41	10.11
GPA			
Low	39	66.58	8.70
High	36	71.90	10.20

Note: Disparate sample sizes are due to the method used to make median splits